

## CLAIMS

1. A gas pressurization system comprising:
  - a gas inlet valve configured to receive an inlet gas stream;
  - a clean-up system coupled to said gas inlet valve, said clean-up system configured to remove impurities from said inlet gas stream;
  - a recovery heat exchanger coupled to said clean-up system, said recovery heat exchanger configured to remove thermal energy from said inlet gas stream and cool said inlet gas stream into one of a pre-cooled gas stream and a pre-cooled liquid stream;
  - an expander coupled to said recovery heat exchanger, said expander configured to expand said pre-cooled liquid stream into a two-phase fluid;
  - a refrigeration unit coupled to said expander, said refrigeration unit configured to cool said two-phase fluid into a liquid phase fluid;
  - a buffer storage unit coupled to said refrigeration unit, said buffer storage unit configured to provide a net positive suction head;
  - a pump coupled to said buffer storage unit at a pump suction, said pump having a pump discharge coupled to said recovery heat exchanger, wherein said recovery heat exchanger is configured to transfer thermal energy from said inlet gas stream to a liquid discharge from said pump discharge; and
  - a high pressure storage unit coupled to said pump discharge downstream of said recovery heat exchanger.

2. The gas pressurization system of claim 1 further comprising:

fluid conduit coupling between said recovery heat exchanger, said expander, said refrigeration unit, said buffer storage unit, said pump, and said recovery heat exchanger, wherein said fluid conduit comprises very low heat gain insulation.

3. The gas pressurization system of claim 2 wherein said very low heat gain insulation comprises a vacuum jacket pipe disposed over an inner pressure carrier pipe, and vacuum and laminar super-insulation.

4. The gas pressurization system of claim 1 further comprising:

a discharge control valve between said recovery heat exchanger and said high pressure storage unit, said discharge control valve configured to control said liquid discharge flow to said high pressure storage unit.

5. The gas pressurization system of claim 1 further comprising:

an energy absorbing device coupled to said expander, wherein said energy absorbing device converts mechanical energy from said expander for use by said refrigeration unit.

6. The gas pressurization system of claim 5 wherein said energy absorbing device comprises at least one of an electrical generator, a gas compressor and a hydraulic pump.
7. The gas pressurization system of claim 1 wherein said expander comprises at least one of a turbo-expander and a Joule-Thomson valve.
8. The gas pressurization system of claim 1, wherein said refrigeration unit is configured to liquefy said vapor to one of a saturated and sub-cooled thermodynamic condition.
9. The gas pressurization system of claim 1 wherein said pump comprises at least one of a submerged multistage centrifugal pump and a positive displacement pump and a plurality of incompressible fluid pumps.
10. The gas pressurization system of claim 1 wherein said high-pressure storage unit comprises at least one of an underground storage reservoir and an above ground storage container.
11. A gas pressurization system comprising:  
a gas inlet valve, configured to receive an inlet natural gas stream;

a clean-up system coupled to said gas inlet valve, said clean-up system configured to remove impurities from said inlet natural gas stream;

a recovery heat exchanger coupled to said clean-up system, said recovery heat exchanger configured to remove thermal energy from said inlet natural gas stream and cool said inlet natural gas stream to one of a pre-cooled natural gas stream and a pre-cooled liquefied natural gas stream;

an expander coupled to said recovery heat exchanger, said expander configured to expand said pre-cooled liquefied natural gas stream into a two phase fluid;

a refrigeration unit coupled to said expander, said refrigeration unit configured to cool said two phase fluid to a liquid phase;

a buffer storage unit coupled to said refrigeration unit, said buffer storage unit configured to provide a net positive suction head;

a pump coupled to said buffer storage unit at a pump suction and said pump having a pump discharge coupled to said recovery heat exchanger, wherein said recovery heat exchanger is configured to transfer thermal energy from said inlet gas stream to a liquefied natural gas discharge from said pump discharge; and

a high pressure storage unit coupled to said pump discharge downstream of said recovery heat exchanger.

12. The gas pressurization system of claim 11, wherein said clean-up system is configured to remove impurities selected from the group consisting of water, carbon dioxide, C6+, heavy hydrocarbons, and sulfur compounds.
13. The gas pressurization system of claim 11 wherein said expander comprises at least one of a turbo-expander and a Joule-Thomson valve.
14. The gas pressurization system of claim 11 further comprising:  
an energy absorbing device coupled to said expander, wherein said energy absorbing device converts mechanical energy from said expander for use by said refrigeration unit, wherein said energy absorbing device comprises at least one of an electrical generator, a gas compressor and a hydraulic pump.
15. The gas pressurization system of claim 14 further comprising:  
a gaseous natural gas stream coupled to said buffer storage unit and configured to provide at least one of a fuel for said refrigeration unit and an additional cooling fluid in said recovery heat exchanger.
16. The gas pressurization system of claim 11 wherein said refrigeration unit comprises at least one of a cascade refrigeration unit, a closed loop refrigeration unit and a plurality of refrigeration units.

17. A method of pressurizing a gas comprising:
- flowing a gas through a gas inlet valve;
  - removing impurities from said gas;
  - precooling said gas in a recovery heat exchanger into one of a gas phase and a liquid phase;
  - expanding said liquid phase to a two-phase fluid through an expander;
  - cooling said two-phase fluid to one of a saturated and a sub-cooled liquid;
  - storing said saturated sub-cooled liquid in a buffer storage unit;
  - maintaining a net positive suction head in said saturated liquid and said sub-cooled liquid;
  - pumping said saturated liquid and said sub-cooled liquid with a pump through said recovery heat exchanger;
  - exchanging thermal energy from said gas to said saturated liquid and said sub-cooled liquid in said recovery heat exchanger; and
  - storing an ambient liquid in a high pressure storage unit.
18. The method of claim 17 wherein said expanding said liquid phase to a two phase fluid includes at least one of expansion through a turbo-expander and expansion through a Joule-Thomson valve.

19. The method of claim 17 further comprising:

absorbing mechanical energy from said expander with an energy absorbing device, said energy absorbing device including at least one of an electrical generator, a gas compressor and a hydraulic pump.

20. The method of claim 17 wherein said gas is natural gas and said liquid is liquefied natural gas.